

**A METHOD OF FORMING A METAL SHEET BLANK**

The present invention relates to a method of forming a metal sheet blank, preferably into a lid or container.

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The present invention further relates to a tool and an apparatus for forming a metal sheet blank, and furthermore the present invention relates to a lid or container.

Background of the invention

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Lids and closures for containers are widely used and produced in great numbers, e.g. for containers for food or chemicals. The lids are often produced by punching a blank of sheet metal in a punching tool. The resulting processed blank comprises a substantially flat first surface and a skirt portion extending at substantially right angles therefrom. The skirt portion normally has an uneven edge due to earring in the punching process. The edge of the skirt portion is relatively sharp and hence must be processed to avoid injury to persons using or handling the lid. It is custom to trim the depending ears of the edge of the skirt portion to provide a skirt portion having an even length, to prepare the skirt portion for a subsequent curling step to produce a curled edge of the skirt. The curled edge provides a smooth and safe edge for any user of the lid.

US 5,749,258 discloses a method and a tool for forming a container body from blanks, preferably hexagonal shaped blanks. The tooling comprises a die for forming a blank into a container body. The die enables the use of a blank of noncircular geometric shape by redistributing metal to produce an end product without excessive earring. The blank is drawn into a cup shape, and the earring provided by the drawing process is subsequently trimmed off in order to obtain an even edge encircling the opening of the container. Said even edge may then be die formed or roll formed.

US 4,862,722 discloses a method of forming a container end from a blank of material wherein the earring is minimised by forming the container from a blank that is multi-sided in configuration rather than circular.

US 4,005,665 discloses a method for preparing a steel blank which is less susceptible to ear occurrence during press-working into a pressed article.

US 6,290,447 discloses a tool station for forming a can end by punching, forming and curling the can end with a single movement of the punch.

There is, however, an ever-growing need for cutting the price of packaging, especially throwaway packaging, such as food packaging.

It is an object to provide an improved method of forming lid or container with a minimum  
5 waste of material to provide low cost lids and/or containers for packaging.

It is a further object to provide a tool for producing a low-cost lid and/or container for packaging.

10 It is also an object to provide a low-cost and safe lid or container.

#### Description of the invention

As mentioned above, commonly metal lids for containers and containers have been  
15 produced by punching, drawing or similar processing of a metal sheet blank. In the punching or drawing process, the normally circular blank is processed into a normally circular lid pre-form having a skirt portion with slightly uneven height due to earring. Accordingly the skirt portion normally is trimmed to provide a skirt portion of even height, and subsequently the lower edge of the skirt portion is processed to provide a curled edge.

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Thus the production of a metal lid for a container comprises many process steps and a certain amount of scrap due to the trimming, and this scrap cannot be used. A lot of effort has been made to reduce the earring, but this is very difficult, e.g. because of directional flow of metal in the process of drawing or punching the blank.

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By the present invention it is realised that the step of trimming the edge can be avoided by taking a totally different approach, namely by using the earring as a part of the final shaped container or lid

30 According to a first aspect, the present invention relates to a method of forming a metal sheet blank, the method comprising the steps of deep-drawing the sheet blank so as to produce a deep-drawn pre-form having a base portion and a skirt portion extending therefrom, the height of said skirt portion varying around the perimeter of the pre-form so as to provide a skirt having a curved edge course, and subsequently processing said  
35 curved edge to obtain a curled or bent edge having a curved course.

This means that a skirt with an uneven edge with earring is deliberately formed, and this uneven edge is processed directly for obtaining an edge of the skirt that is curled or bent while still having a curved course (when seeing the skirt portion from the side, i.e.

substantially perpendicular to the skirt portion), hence avoiding the time-consuming intermediate processing step of trimming the uneven edge off, thereby also reducing the amount of scrap in the process. Thus, the earring is used as a part of the final shape instead of trimming it off.

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The skirt portion preferably extends substantially at right angles from the base portion, but it may extend in angles below or above 90 degrees.

The blank may be provided in any convenient way, such as by laser cutting, according to an embodiment, however, the method comprises an initial step of punching the blank into a circular or non-circular shape from a basic metal sheet. Hereby a simple, cost-effective and convenient way of providing the blank is achieved. Though, the blank have a circular shape, the deep-drawn pre-form will still have a skirt portion having earrings (a curved edge course), because of directional flow of metal in the process of drawing the blank.

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The individual process steps may be provided as separate, temporally and spatially remote processes, according to an embodiment, however, the process steps are performed in one sequence of operations, i.e. sequentially punching the blank, deep-drawing the blank to a pre-form, and curling the curved edge of the pre-form in one go, which will be appreciated by the skilled person as an effective and convenient way of providing deep-drawn pre-forms from a basic metal sheet.

In a preferred embodiment, the method comprises the steps of:

- 25 – providing a first tool part having a curling portion, said curling portion forming a three-dimensional path in the tool to enable formation of said curled edge having a curved edge course,
- providing a second tool part opposite in relation to said first tool, said second tool having a die cavity,
- 30 – providing a punch in an opening in the first tool part, said punch being movable in relation to the first tool part to extend beyond a plane of the first tool part so as to be received in said die cavity of the second tool upon moving the second tool part in relation to said punch,
- placing said sheet blank between the first and second tool part,
- 35 – deep-drawing said sheet blank by moving the first and second tool in relation to said punch, or vice versa, so that the punch moves into said cavity of the second tool and thereby deep-draws the sheet blank into said pre-form, and subsequently

- processing said curved edge by moving said pre-form towards the first tool part, or vice versa, for abutment of the curved edge of the pre-form with the curling portion to provide a curled curved edge.
- 5 The method preferably comprises the step of pressing said pre-form towards the punch before the step of processing, said step of pressing may be provided by mechanical or hydraulic or pneumatic means, such as a further punch or piston(s) provided within the cavity of the second tool part.
- 10 Said further punch or piston(s) preferably presses the base portion of the pre-form towards said punch of the first tool in order to keep the pre-form in position while moving first tool part towards the pre-form for abutment of the curved edge of the pre-form with the curling portion.
- 15 Alternatively, the first tool part may be maintained in its position while moving the pre-form towards the first tool part for abutment of the curved edge of the pre-form with the curling portion.

Punching/cutting means may be provided between the first and second tool part,

- 20 preferably on the first and/or second tool part, and the step of punching may comprise moving the first tool part towards the second tool part for cutting out said sheet blank from a sheet of metal.

- According to a second aspect, the present invention relates to tool comprising a first tool
- 25 part having a curling portion, said curling portion forming a three-dimensional path in the tool to enable formation of a curled edge on a metal pre-form having a curved edge course. Hereby a tool is provided which can process a pre-form having a curved edge course directly in order to obtain a curled curved edge course of the pre-form.

- 30 The pre-form is formed from a metal sheet blank that may be provided in any convenient way, such as by cutting or by means of a laser, for example in an independent tool.

- According to an embodiment, however, the tool further comprises a cutting edge adapted to provide/cut a sheet blank having a circular or non-circular shape. Hereby is achieved an
- 35 effective combination tool providing means for cutting the sheet blank and curling a curved edge of a pre-form, avoiding the need for more tools and eliminating the time consumed in moving a blank from one tool to another.

The sheet blank may be machined in a separate tool to produce the pre-form, according to an embodiment, however, the tool further comprises a punch movable in an opening arranged in the first tool part, whereby the punch is movable to extend beyond a plane of the first tool part.

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According to an embodiment, the tool further comprises a second tool part having a die cavity. The second tool part is oppositely arranged in relation to said first tool, and the die cavity is adapted to receive said punch upon moving said second tool part in relation to said punch so as to allow deep-drawing of a metal sheet blank, provided between the first  
10 and second tool, into said metal pre-form.

The cutting edge may be provided on the first or second tool so as to cut out said sheet blank upon moving said first and second tool towards each other.

15 The cutting edge may be provided on a third tool arranged adjacent to said first and/or second tool, so as to cut out said blank upon moving said first or second tool towards said third tool.

Hereby an effective exploitation of the tool is achieved, as the blank may be cut and drawn  
20 and/or having an edge curled in the same tool, and hence it is not required to move the blank to another tool.

According to another embodiment, the tool further comprises a second punch or piston(s) moveable to press the pre-form towards the first tool part or to keep the pre-form in  
25 position while pressing the first tool part towards the pre-form for abutment of the curved edge of the metal pre-form with the curling portion to provide a curled curved edge.

According to a third aspect, the invention relates to an apparatus for deep-drawing a metal sheet blank, said apparatus comprising a female tool part for receiving a male tool part  
30 when deep-drawing said metal sheet blank to produce a pre-form having a base portion and a skirt portion extending at substantially right angles therefrom, the height of said skirt portion varying around the perimeter of the pre-form so as to provide a skirt having a curved edge course, said apparatus further comprising a curling tool for curling said curved edge. Hereby an effective combination apparatus is achieved to both deep-drawing a metal  
35 sheet to produce a pre-form and subsequently curling the curved edge portion directly so as to obtain a curled edge having a curved course.

The curling tool may be a kind of roller to be pressed against the curved edge and travel around the perimeter of the skirt, according to an embodiment, however, the curling tool

comprises a curling portion forming a three-dimensional path in a tool part to enable formation of a curled edge on a metal pre-form having a curved edge course. Hereby a simple, low-cost curling tool is provided which allows for a process of producing e.g. lids or containers with a minimum waste of material, as the step of trimming off the uneven edge  
5 is avoided, and which allows for a much less time consuming and thus a cheaper process.

To provide an efficient combination apparatus, the apparatus may further comprise cutting means for cutting the sheet blank into a non-circular shape prior to deep-drawing.

10 According to a fourth aspect, the present invention relates to an apparatus for deep-drawing a metal sheet blank and comprising a tool according to the second aspect of the present invention.

According to a fifth aspect, the present invention relates to an apparatus for deep-drawing  
15 a metal sheet blank and adapted to perform the step of the method according to the first aspect of the present invention.

According to a sixth aspect, the invention relates to a metal lid or container having a base portion and a skirt portion extending at substantially right angles therefrom, the height of  
20 said skirt portion varying around the perimeter of the lid or container so as to provide a skirt having a curved edge course, said curved edge further being curled. Hereby a distinctive lid or container is provided.

That the height varies along the perimeter means the height may be the same at some  
25 locations around the perimeter, but not the same along the entire perimeter of the pre-form. Thus, the curved edge may have a course consisting of curves and/or straight lines. The height of the skirt portion may have any convenient value. However according to an embodiment the height is in the range of 0 to 20 cm to enable drawing in one step.

30 According to an embodiment the lid or container has a circular, non-circular, organic or polygonal shape, or a combination of one or more shapes.

According to a seventh aspect, the invention relates to a metal lid or container having a base portion and a skirt portion extending therefrom and terminating in a curled edge, the  
35 height of said skirt portion varies around the perimeter of the lid or container.

The metal lid or container may be produced by the method, tool and apparatus mentioned above.

In the following the invention will be discussed in more detail by way of example and with reference to the drawing, in which:

Fig. 1 is a cross-sectional view of a first tool part of a tool according to the invention,

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Fig. 2 is a schematic cross-sectional view of a tool with a work-piece,

Fig. 3 is an isometric view of the first tool part of the tool,

10 Fig. 4 is a blank for producing a lid,

Fig. 5 is a side view of a lid mounted to a container, and

Fig. 6 is an isometric view of a lid,

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Fig. 7-9 is a very schematic illustration of apparatus according to the invention in different process steps, and

Fig. 10a-f shows the steps of a preferred method of forming the metal sheet blank

20 according to the invention.

In Fig. 1 a first tool part 1 of a tool can be seen (e.g. a cross-sectional view of the tool shown in fig. 3). The first tool part 1 comprises a cavity 2 adapted to accommodate a part of a work-piece (not shown), and the cavity 2 has an inner guiding surface 3 for the work-  
25 piece, and a (bead forming part)/curling portion 4 provided at the lower end of the inner guiding surface 3 in the Figure. The curling portion 4 is formed of a substantially semi-circular part, which as shown may be machined into the wall of the cavity 2 of the first tool part 1.

30 The first tool part 1 may further comprise an opening 5 adapted to receive a punch (not shown) moveable to extend beyond the face of the first tool part 1.

The functioning of the tool can be seen in Fig. 2, which is a cross-sectional view of a portion of the first tool part 1 and a second tool part 6 placed opposite on top of the first  
35 tool part 1. A work-piece (metal sheet blank) 7 is further seen in the tool of Fig. 2. The work-piece 7 is either pressed up by the punch 14 or pressed down by the tools 1,6 and formed to a lid pre-form having a substantially planar top face 8 (base portion) and a skirt portion 9 extending downward at right angles to the top face 8. As illustrated the lower

edge 10 of the skirt portion 9 may be bent slightly outwards. The lid pre-form 7 has a skirt portion 9 of uneven height, as can be seen in Fig. 5.

In a subsequent step the lid pre-form 7 may be forced downwards together with the punch 14 within the second tool part 6 by a further punch or piston (shown in figs 10a-f), but preferably the tools 1,6 are moved upwards while keeping the punch 14, work-piece 7 and the further punch or piston (shown in figs. 10a-f) stationary, such that the pre-form is pressed into the cavity 2 of the first tool part following the inner guiding face 3 until the lower edge 10 abuts the curling portion 4 of the first tool part. By further movement of the lid pre-form 7 or the tools 1,6 the lower edge 10 of the skirt portion 9 follows the semi-circular part of the curling portion 4, whereby the lower edge 10 is curled or bent forming a bead at the lower edge 10 of the skirt portion 9.

The first tool part 1 is seen in whole in Fig. 3. As can be seen, the first tool part comprises a cavity with a circular through-going hole 5 and a curling portion 4 forming a three-dimensional path in the tool to enable formation of a curled edge on the pre-form 7 having a curved edge course is provided in the wall of the cavity. The curling portion 4 is arranged all the way round the cavity 2 and is arranged in differing height. The first tool part 1 further comprises a cutting edge 11 extending around the non-circular periphery of the first tool part 1. By pressing a sheet metal plate against the cutting edge 11, a blank for a lid can be formed as can be seen in Fig. 4.

The blank 12 illustrated in Fig. 4 has a non-circular shape with an undulating edge. Obviously, the blank may deviate more or less from a circular shape, and instead of the shown organic shape, the blank may have a polygonal shape or a combination of one or more shapes.

In Fig. 5 and 6 is shown an example of a finished lid 13 (fig. 5 shows a lid mounted to a container) having a skirt portion 9 of uneven height. The lower edge 10 of the skirt portion 9 is curled according to the invention to provide a safe, blunt edge, which will not be a hazard in respect of the risk of scratches or cuts in e.g. fingers when using the lid. Further the somewhat larger curled portion extending from the plane of the skirt portion facilitates manipulation of the lid by a user, such as when fitting the lid on a container or when removing the lid from a container. Normally the curled portion will be provided at a radial outward position of the skirt portion 9, but alternatively the curled portion may be provided at a radial inward position or in an intermediate position. The curled portion may as shown have a substantially circular cross-section or alternatively a flattened, folded cross-section.



As shown fig. 5, the uneven height of the skirt also allows for providing a lid and container combination, wherein an hole 23 in the container 22 can be closed and opened by turning the lid such that the earring 24 obstructs the hole. For example the embodiment of fig. 5 may be used as a cream jug or another pouring device.

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Figs. 7 to 9 illustrate cross-sections of the apparatus in different process steps. In Fig. 7 is seen a first step of punching a metal sheet 7 to produce a blank 7, preferably not circular. The first tool part 1 comprises a cutting edges 11 and the metal sheet is pressed against the cutting edges by urging the first and second tool parts 1 and 6 together. The subsequent deep-drawing step is shown in Fig. 8, where it can be seen that a punch 14 is forced up through the first tool part 1 and deep-drawing the blank to a pre-form 16 in a cavity 15 of the second tool part 6, the pre-form having a base portion and skirt portion extending from the base portion and having a curved edge.

15 The final process step is illustrated in Fig. 9, where it can be seen that the punch 14 is retracted and the pre-form 16 is forced against the curling portion 17 of the first tool part 1 to form a curled edge 18 on the pre-form 16. The pre-form 16 is forced downwards by a punch 19 provided in the cavity 15 of the second tool part 6. This punch may be actuated mechanically (such as spring-loaded) or by hydraulic or pneumatic pressure. The curled edge 17 of the pre-form has a curved course, but it is not shown in the figure.

Figs. 10a-f show preferred steps of forming a metal sheet blank according to the invention. A metal sheet 7 is positioned between the first tool part 1 and the second tool part 6, and first tool part 1 and the punch 19 is moved downwards, and when the punch 19 abuts the metal sheet 7, it stops moving. The first tool part 1 punches a blank from the sheet of metal, as it passes the cutting edge 20 of a third tool 21 provided adjacent thereto. Now, the first and second tool part 1,6 are moved downwards while keeping the punches 14, 19 stationary such that a pre-form 16 is deep-drawn (fig. 10b).

30 Then, the first and second tool part 1,6 are returned upwards while keeping the punches 14, 19 stationary, such that the pre-form 16 is forced against the curling portion 17 of the first tool part 1 to form a curled curved edge 18 on the pre-form 16.

Due to the deep-drawing process, the final formed lid or container 16 is wedged inside the second tool part 6 and by moving the second tool part 16 further upwards while keeping the punch 19 stationary (it may e.g. abut a stop), the article 16 will be pushed out of the tool.

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Thus, a lid or container is produced in one sequence of operations, i.e. sequentially punching the blank, deep-drawing the blank to a lid or container pre-form, and finally curling the edge of the pre-form in one go, and the curled edge has a curved course, as shown in fig. 5 and 6.

## CLAIMS

1. A method of forming a metal sheet blank, the method comprising the steps of;
  - 5 - deep-drawing the sheet blank so as to produce a deep-drawn pre-form having a base portion and a skirt portion extending at substantially right angles therefrom, the height of said skirt portion varying around the perimeter of the pre-form so as to provide a skirt having a curved edge course, and subsequently
  - 10 - processing said curved edge to obtain a curled or bent edge having a curved course.
2. A method according to claim 1, further comprising an initial step of punching the blank into circular or non-circular shape from a basic metal sheet.
- 15 3. A method according to claim 1 or 2, wherein the process steps are performed in one sequence of operations, i.e. sequentially punching the blank, deep-drawing the blank to a pre-form, and curling and/or bending the edge of the pre-form in one go.
4. A method according to any of claims 1-3, and comprising:
  - 20 - providing a first tool part having a curling portion, said curling portion forming a three-dimensional path in the tool to enable formation of said curled edge having a curved edge course,
  - providing a second tool part opposite in relation to said first tool, said second tool
    - 25 having a die cavity,
    - providing a punch in an opening in the first tool part, said punch being movable in relation to the first tool part to extend beyond a plane of the first tool part so as to be received in said die cavity of the second tool upon moving the second tool part in relation to said punch,
    - 30 - placing said sheet blank between the first and second tool part,
    - deep-drawing said sheet blank by moving the first and second tool in relation to said punch, or vice versa, so that the punch moves into said cavity of the second tool and thereby deep-draws the sheet blank into said pre-form, and subsequently
    - processing said curved edge by moving said pre-form towards the first tool part, or
      - 35 vice versa, for abutment of the curved edge of the pre-form with the curling portion to provide a curled curved edge.

5. A method according to claim 4, further comprising the step of pressing said pre-form towards the punch before the step of processing, said step of pressing being provided by mechanical or hydraulic or pneumatic means.
- 5 6. A method according to any of claims 2-5, wherein punching/cutting means are provided between the first and second tool part on the first and/or second tool part, the step of punching comprising moving the first tool part towards the second tool part for cutting out said sheet blank from a sheet of metal.
- 10 7. A method according to any of claims 1-6, wherein the sheet blank is circular or non-circular, such as polygonal.
8. A tool comprising a first tool part having a curling portion, said curling portion forming a three-dimensional path in the tool to enable formation of a curled edge on a metal pre-  
15 form having a curved edge course.
9. A tool according to claim 8, further comprising a cutting edge adapted to provide a sheet blank having a circular or non-circular shape from a sheet of metal and which blank is adapted to be formed into said pre-form.
- 20 10. A tool according to claim 8 or 9, further comprising a punch movable in an opening arranged in the first tool part, whereby the punch is movable to extend beyond a plane of the first tool part.
- 25 11. A tool according to claim 10, further comprising a second tool part oppositely arranged in relation to said first tool and having a die cavity adapted to receive said punch upon moving said second tool part in relation to said punch so as to allow deep-drawing of a metal sheet blank, provided between the first and second tool, into said metal pre-form.
- 30 12. A tool according to any of claims 8-11, wherein the cutting edge is provided on the first or second tool so as to cut out said sheet blank upon moving said first and second tool towards each other.
13. A tool according to any of claims 8-12, wherein the cutting edge is provided on a third  
35 tool arranged adjacent to said first and/or second tool, so as to cut out said blank upon moving said first or second tool towards said third tool.

14. A tool according to any of the claims 8-13, further comprising a second punch or piston to press the pre-form towards the first tool part or to keep the pre-form stationary while pressing the first tool part towards the pre-form for abutment of the curved edge of the metal pre-form with the curling portion to provide a curled curved edge.

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15. An apparatus for deep-drawing a metal sheet blank, said apparatus comprising a female tool part for receiving a male tool part when deep-drawing said metal sheet blank to produce a pre-form having a base portion and a skirt portion extending at substantially right angles therefrom, the height of said skirt portion varying around the perimeter of the pre-form so as to provide a skirt having a curved edge course, said apparatus further comprising a curling tool for curling said curved edge.

16. An apparatus according to claim 15, wherein the curling tool comprises a curling portion forming a three-dimensional path in a tool part to enable formation of a curled edge on said metal pre-form having a curved edge course.

17. An apparatus according to claim 15 or 16, further comprising cutting means for cutting the sheet blank into a circular or non-circular shape prior to deep-drawing.

18. An apparatus for deep-drawing a metal sheet blank and comprising a tool according to any of claims 8-14.

19. An apparatus for deep-drawing a metal sheet blank and adapted to perform the step according to the method of claims 1-7.

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20. A metal lid or container having a base portion and a skirt portion extending at substantially right angles therefrom, the height of said skirt portion varying around the perimeter of the lid or container so as to provide a skirt having a curved edge course, said curved edge further being curled.

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21. A metal lid or container having a base portion and a skirt portion extending therefrom and terminating in a curled edge, the height of said skirt portion varies around the perimeter of the lid or container.

22. A metal lid or container according to claim 20 or 21, wherein said height is in the range of 0 to 20 cm.

23. A metal lid or container according to any of the claims 20-22, wherein the lid or container has a circular, non-circular, organic or polygonal shape, or a combination of one or more shapes.

- 5 24. A metal lid or container according to any of the claims 20-23, and produced by the method, tool and apparatus according to any of the claims 1-19.

## ABSTRACT

A method of forming a metal sheet blank (7) by deep-drawing the sheet blank (7) so as to produce a deep-drawn pre-form (7) having a base portion (8) and a skirt portion (9)

- 5 extending at substantially right angles therefrom. The height of the skirt portion (9) varies around the perimeter of the pre-form (7) so as to provide a skirt (9) having a curved edge course (10), and subsequently processing said curved edge (10) to obtain a curled or bent edge (10) having a curved course. The invention also relates to a tool (1,6) and an apparatus for forming a sheet blank and to a lid or container (7).

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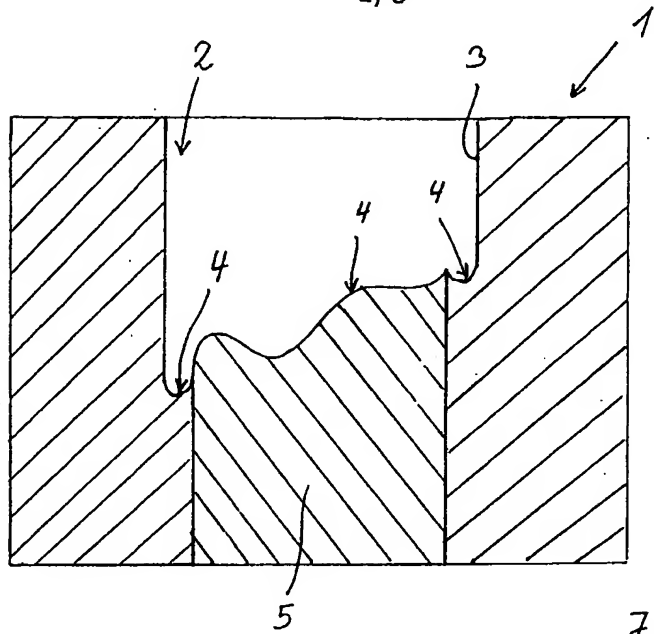


Fig. 1

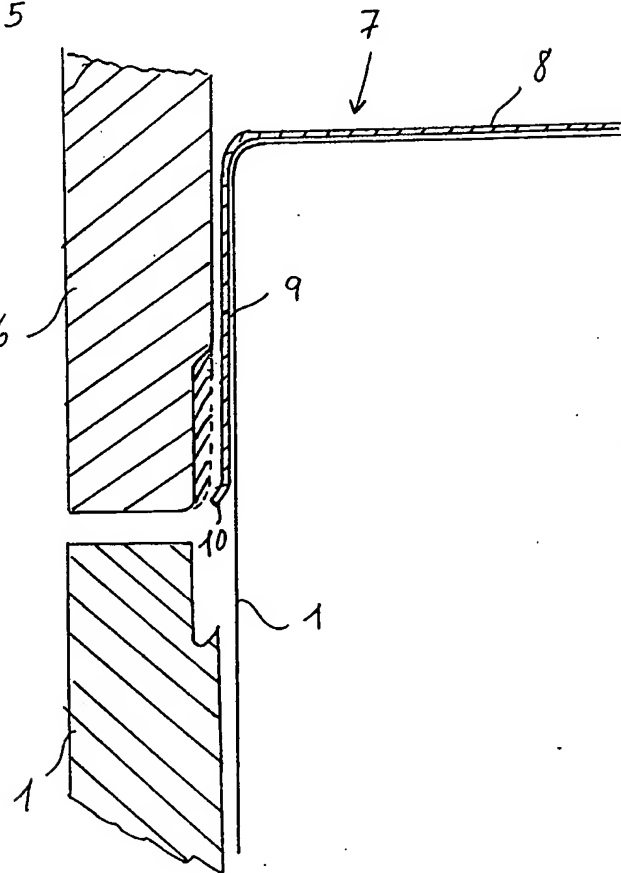


Fig. 2



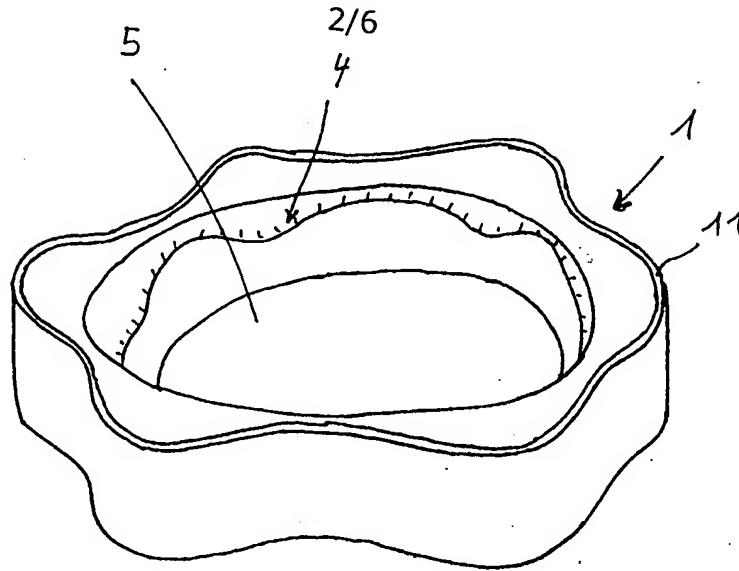


Fig. 3

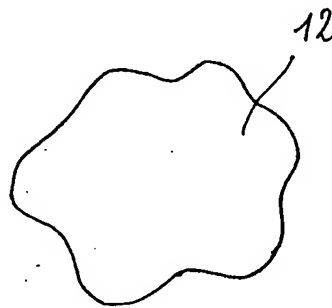


Fig. 4

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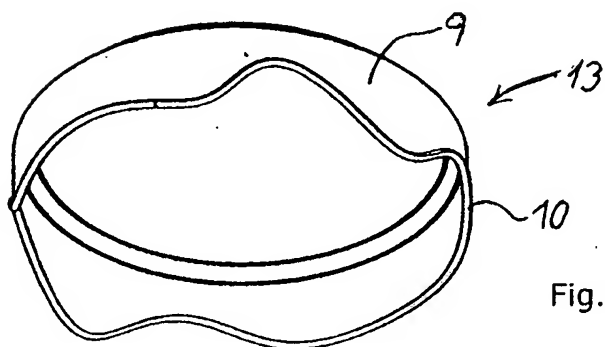


Fig. 6

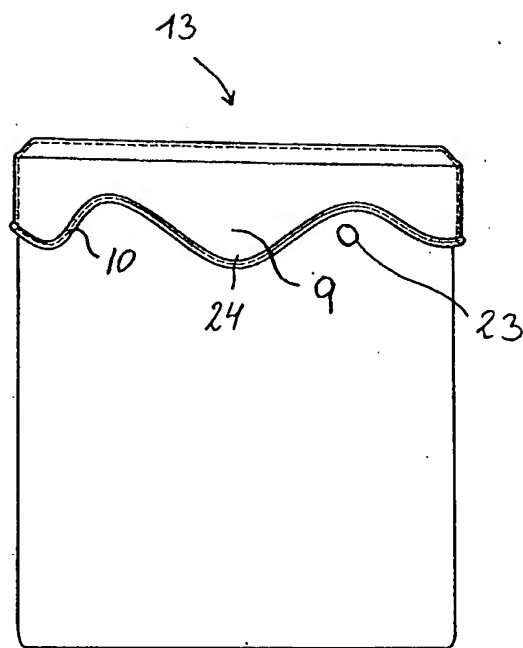


Fig. 5

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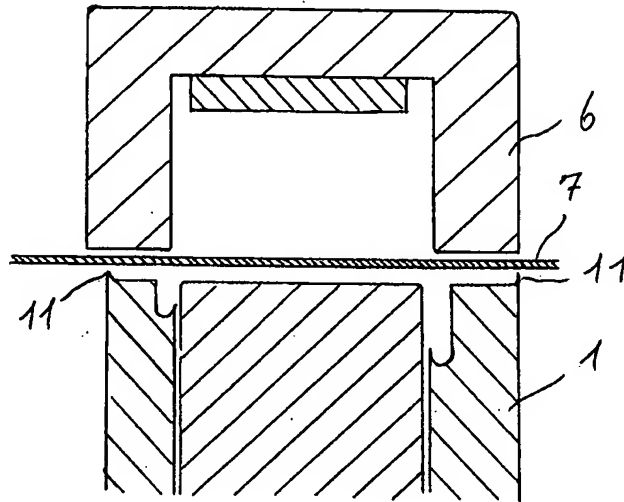


Fig. 7

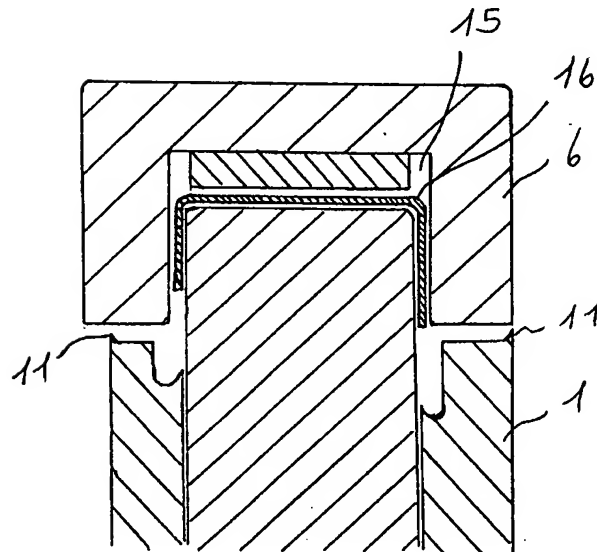


Fig. 8

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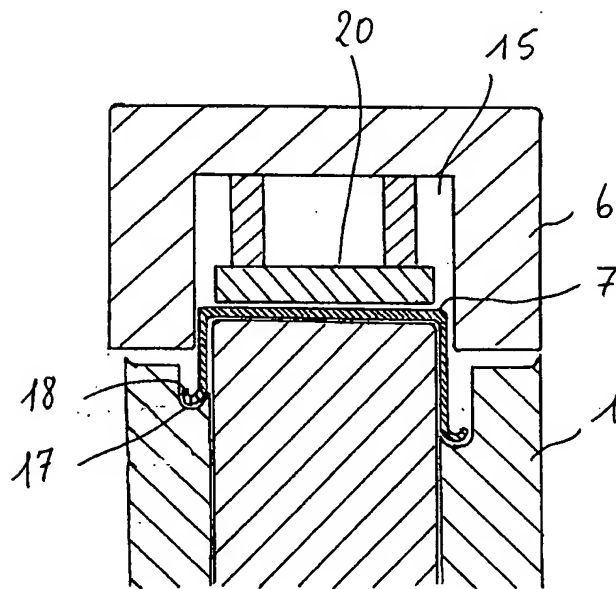


Fig. 9

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